A predator in need is a predator indeed: generalist arthropod predators function as pest specialists at the late growth stage of rice

Gen-Chang Hsu[1], Jia-Ang Ou[2,3], Min-Hsuan Ni[2], Zheng-Hong Lin[2] and Chuan-Kai Ho[1,2*]

[1]Department of Life Science, National Taiwan University, Taipei, Taiwan

[2]Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan

[3]Department of Zoology, University of British Columbia, Vancouver, Canada

* Corresponding author. ORCiD ID: http://orcid.org/0000-0002-6437-0073 Email: ckho@ntu.edu.tw

Appendix S1

Table S1. The taxonomic information and trophic guilds of the arthropod samples in the three study years.

(a) Year 2017

Trophic guild	Order	Family/Genus
Predators	Araneae	Araneidae
	Araneae	Clubionidae
	Araneae	Oxyopidae
	Araneae	Tetragnathidae
	Araneae	Thomisidae
	Coleoptera	Carabidae
	Coleoptera	Coccinellidae
Rice herbivores	Hemiptera	Cicadellidae/*Nephotettix*
	Hemiptera	Delphacidae/*Nilaparvata*
	Hemiptera	Lygaeidae/*Pachybrachius*
	Hemiptera	Pentatomidae/*Scotinophara*
	Lepidoptera	Hesperiidae
	Lepidoptera	Pyralidae
	Lepidoptera	Nymphalidae
	Orthoptera	Pyrgomorphidae/*Atractomorpha*
Tourist herbivores	Coleoptera	Chrysomelidae
	Orthoptera	Acrididae
Detritivores	Diptera	Chironomidae
	Diptera	Chloropidae
	Diptera	Ephydridae
	Diptera	Muscidae
	Diptera	Sphaeroceridae

	Diptera	Stratiomyidae
	Diptera	Tephritidae
	Orthoptera	Tetrigidae

(b) Year 2018

Trophic guild	Order	Family/Genus
Predators	Araneae	Araneidae
	Araneae	Clubionidae
	Araneae	Oxyopidae
	Araneae	Tetragnathidae
	Araneae	Thomisidae
	Coleoptera	Coccinellidae
Rice herbivores	Hemiptera	Alydidae/*Leptocorisa*
	Hemiptera	Cicadellidae/*Nephotettix*
	Hemiptera	Delphacidae/*Nilaparvata*
	Hemiptera	Lygaeidae/*Pachybrachius*
	Hemiptera	Pentatomidae/*Scotinophara*
	Lepidoptera	Hesperiidae
	Lepidoptera	Pyralidae
	Orthoptera	Pyrgomorphidae/*Atractomorpha*
Tourist herbivores	Coleoptera	Chrysomelidae
	Orthoptera	Acrididae
Detritivores	Diptera	Chironomidae
	Diptera	Chloropidae
	Diptera	Ephydridae
	Diptera	Muscidae
	Diptera	Sciomyzidae
	Diptera	Stratiomyidae
	Orthoptera	Tetrigidae

18 (c) Year 2019

Trophic guild	Order	Family/Genus
Predators	Araneae	Araneidae
	Araneae	Clubionidae
	Araneae	Oxyopidae
	Araneae	Tetragnathidae
	Araneae	Thomisidae
	Coleoptera	Coccinellidae
Rice herbivores	Diptera	Agromyzidae
	Hemiptera	Alydidae/*Leptocorisa*
	Hemiptera	Cicadellidae/*Nephotettix*
	Hemiptera	Coreidae
	Hemiptera	Delphacidae/*Nilaparvata*
	Hemiptera	Lygaeidae/*Pachybrachius*
	Hemiptera	Miridae
	Hemiptera	Pentatomidae/*Scotinophara*
	Hemiptera	Ricaniidae
	Lepidoptera	Hesperiidae
	Lepidoptera	Nymphalidae
	Lepidoptera	Pyralidae
	Orthoptera	Pyrgomorphidae/*Atractomorpha*
Tourist herbivores	Coleoptera	Chrysomelidae
	Orthoptera	Acrididae
Detritivores	Diptera	Calliphoridae
	Diptera	Chironomidae
	Diptera	Chloropidae
	Diptera	Ephydridae
	Diptera	Lauxaniidae

	Diptera	Muscidae
	Diptera	Phoridae
	Diptera	Platystomatidae
	Diptera	Sarcophagidae
	Diptera	Sciomyzidae
	Diptera	Sphaeroceridae
	Diptera	Stratiomyidae
	Diptera	Tephritidae
	Orthoptera	Tetrigidae
	Orthoptera	Tridactylidae

19

Table S2. The proportions (mean ± SE) of prey sources (rice herbivores, tourist herbivores, detritivores) consumed in predators' diet in organic and conventional rice farms over crop stages in each study year. *n* represents the number of replicate farms for the diet estimation (Note that the differences in *n* within the same study year were due to the absence of predators in the sweep-net samples in some replicate farms).

Year	Farm type	Crop stage	Predator	Source			*n*
				Rice herbivore	Tourist herbivore	Detritivore	
2017	Organic	Tillering	All	0.27 ± 0.08	0.19 ± 0.05	0.54 ± 0.12	3
			Spider	0.21 ± 0.13	0.33 ± 0.16	0.46 ± 0.18	3
			Ladybeetle	0.74	0.09	0.17	1
		Flowering	All	0.82 ± 0.04	0.13 ± 0.04	0.05 ± 0.03	3
			Spider	0.69 ± 0.15	0.25 ± 0.15	0.06 ± 0.04	3
			Ladybeetle	0.79	0.09	0.12	1
		Ripening	All	0.92 ± 0.02	0.07 ± 0.02	0.02 ± 0.01	3
			Spider	0.78 ± 0.12	0.19 ± 0.12	0.03 ± 0.02	3
			Ladybeetle	0.93 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	3
	Conventional	Tillering	All	0.23 ± 0.01	0.17 ± 0.05	0.59 ± 0.05	3
			Spider	0.25 ± 0.01	0.2 ± 0.06	0.55 ± 0.08	3
			Ladybeetle	0.80	0.08	0.12	1
		Flowering	All	0.83 ± 0.03	0.12 ± 0.03	0.05 ± 0.01	3
			Spider	0.85 ± 0.02	0.11 ± 0.03	0.04 ± 0.01	3
			Ladybeetle	0.88 ± 0.02	0.06 ± 0.01	0.06 ± 0.01	2
		Ripening	All	0.92 ± 0.02	0.06 ± 0.02	0.02 ± 0.01	3
			Spider	0.91 ± 0.01	0.07 ± 0.02	0.02 ± 0.01	3
			Ladybeetle	0.95 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	2
2018	Organic	Tillering	All	0.23 ± 0.03	0.22 ± 0.05	0.55 ± 0.06	7
			Spider	0.20 ± 0.02	0.28 ± 0.07	0.52 ± 0.07	7
			Ladybeetle	0.81 ± 0.02	0.08 ± 0.01	0.11 ± 0.01	6
		Flowering	All	0.75 ± 0.04	0.17 ± 0.04	0.07 ± 0.02	6
			Spider	0.73 ± 0.07	0.20 ± 0.07	0.08 ± 0.04	5
			Ladybeetle	0.82 ± 0.01	0.09 ± 0.01	0.09 ± 0.01	3

		Ripening	All	0.92 ± 0.02	0.05 ± 0.01	0.02 ± 0.01	5
			Spider	0.85 ± 0.04	0.11 ± 0.03	0.05 ± 0.03	4
			Ladybeetle	0.94 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	5
	Conventional	Tillering	All	0.47 ± 0.07	0.15 ± 0.02	0.38 ± 0.05	7
			Spider	0.48 ± 0.10	0.19 ± 0.03	0.33 ± 0.08	7
			Ladybeetle	0.83 ± 0.02	0.07 ± 0.01	0.10 ± 0.01	4
		Flowering	All	0.90 ± 0.03	0.07 ± 0.02	0.02 ± 0.01	6
			Spider	0.87 ± 0.06	0.10 ± 0.04	0.03 ± 0.02	6
			Ladybeetle	0.86 ± 0.03	0.07 ± 0.01	0.07 ± 0.02	2
		Ripening	All	0.95 ± 0.01	0.04 ± 0.01	0.01 ± 0.01	7
			Spider	0.93 ± 0.05	0.06 ± 0.04	0.01 ± 0.01	2
			Ladybeetle	0.94 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	5
2019	Organic	Tillering	All	0.25 ± 0.08	0.19 ± 0.06	0.55 ± 0.06	7
			Spider	0.31 ± 0.10	0.15 ± 0.06	0.54 ± 0.09	7
			Ladybeetle	0.85 ± 0.04	0.08 ± 0.01	0.07 ± 0.03	3
		Flowering	All	0.74 ± 0.12	0.20 ± 0.11	0.06 ± 0.01	7
			Spider	0.77 ± 0.15	0.18 ± 0.14	0.05 ± 0.02	6
			Ladybeetle	0.87 ± 0.02	0.07 ± 0.01	0.06 ± 0.02	3
		Ripening	All	0.79 ± 0.16	0.19 ± 0.16	0.02 ± 0.01	5
			Spider	0.78 ± 0.17	0.19 ± 0.16	0.03 ± 0.01	5
			Ladybeetle	0.94 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	5
	Conventional	Tillering	All	0.37 ± 0.04	0.17 ± 0.04	0.46 ± 0.06	7
			Spider	0.41 ± 0.06	0.17 ± 0.05	0.42 ± 0.08	7
			Ladybeetle	0.84 ± 0.01	0.07 ± 0.01	0.09 ± 0.01	2
		Flowering	All	0.89 ± 0.02	0.08 ± 0.02	0.03 ± 0.01	7
			Spider	0.91 ± 0.02	0.06 ± 0.02	0.02 ± 0.01	7
			Ladybeetle	0.89 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	6
		Ripening	All	0.95 ± 0.01	0.05 ± 0.01	0.01 ± 0.01	5
			Spider	0.94 ± 0.02	0.05 ± 0.02	0.01 ± 0.01	5
			Ladybeetle	0.95 ± 0.01	0.04 ± 0.01	0.02 ± 0.01	3

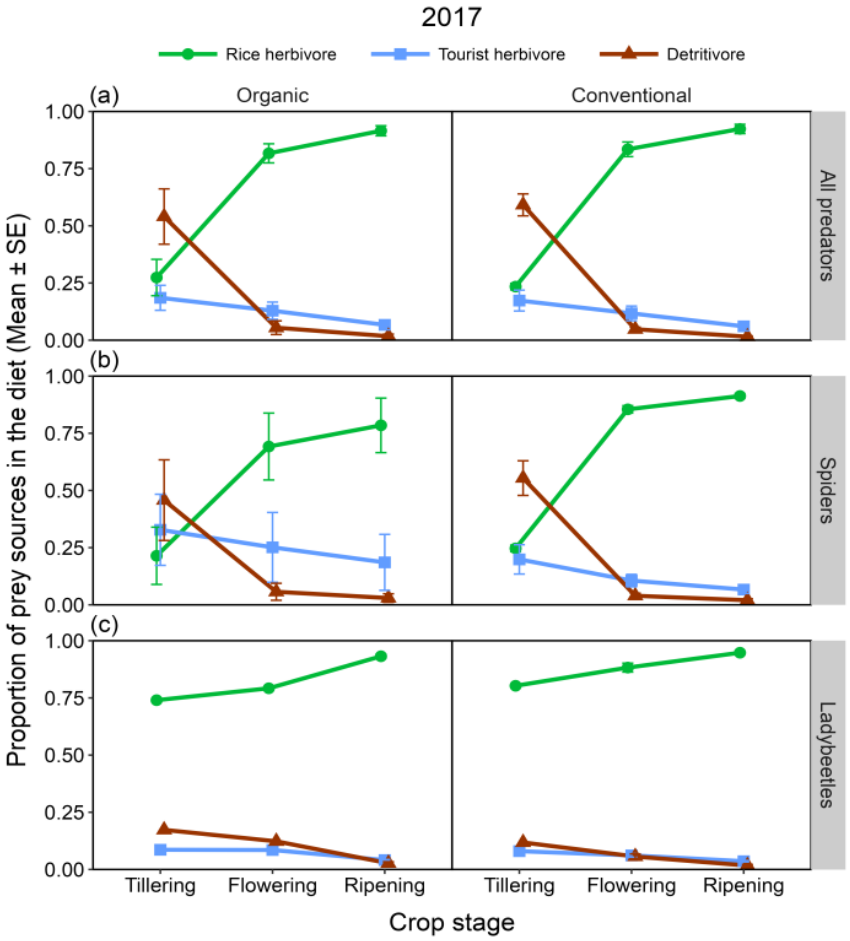
Table S3. The relative abundance of the major families/genera in rice herbivore guild at the flowering and ripening stages in the three study years. Samples were pooled across the replicate farms.

(a) Flowering stage

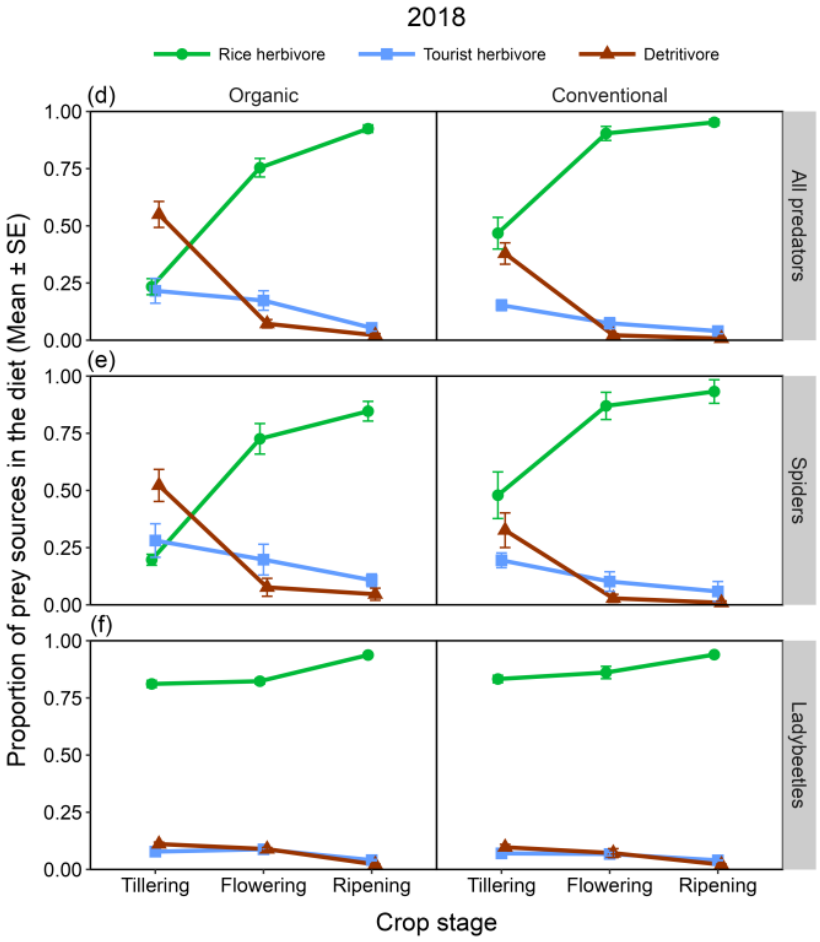
Family/Genus	Year 2017	Year 2018	Year 2019
Cicadellidae/*Nephotettix*	7.6%	22.5%	69.7%
Delphacidae/*Nilaparvata*	88.2%	71.9%	25.4%
Lygaeidae/*Pachybrachius*	*NA*	0.8%	1.3%
Pentatomidae/*Scotinophara*	0.8%	2.9%	0.8%
Others	3.4%	1.9%	2.8%
Total	100%	100%	100%

(b) Ripening stage

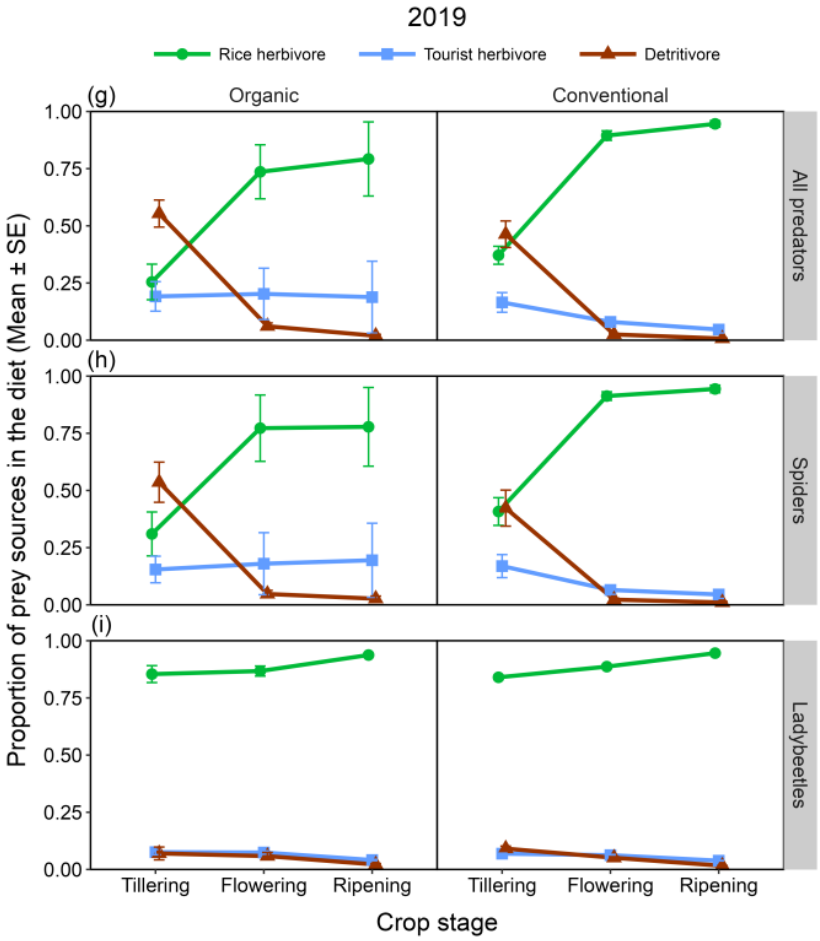
Family/Genus	Year 2017	Year 2018	Year 2019
Cicadellidae/*Nephotettix*	69.4%	74.9%	83.5%
Delphacidae/*Nilaparvata*	28.9%	13.4%	6.2%
Lygaeidae/*Pachybrachius*	*NA*	0.2%	4.1%
Pentatomidae/*Scotinophara*	1.7%	10.4%	4.5%
Others	*NA*	1.1%	1.7%
Total	100%	100%	100%


2017
Rice herbivore
Tourist herbivore
Detritivore
(a)
Organic
Conventional
All predators
(b)
Spiders
(c)
Ladybeetles
Proportion of prey sources in the diet (Mean ± SE)
1.00
0.75
0.50
0.25
0.00
Tillering
Flowering
Ripening
Crop stage

32


2018
Rice herbivore
Tourist herbivore
Detritivore
(d)
Organic
Conventional
All predators
(e)
Spiders
(f)
Ladybeetles
Proportion of prey sources in the diet (Mean ± SE)
1.00
0.75
0.50
0.25
0.00
Tillering
Flowering
Ripening
Crop stage

33



34

35 **Figure S1**. The proportions (mean ± SE) of prey sources (rice herbivores, tourist herbivores,
36 detritivores) consumed in the diet of predators in organic and conventional rice farms over crop
37 stages in each study year: (a), (d), and (g) indicate all predators as a whole feeding guild; (b), (e),
38 and (h) indicate spiders; (c), (f), and (i) indicate ladybeetles. The proportions were computed
39 from the Bayesian posterior means of replicate farms.

40

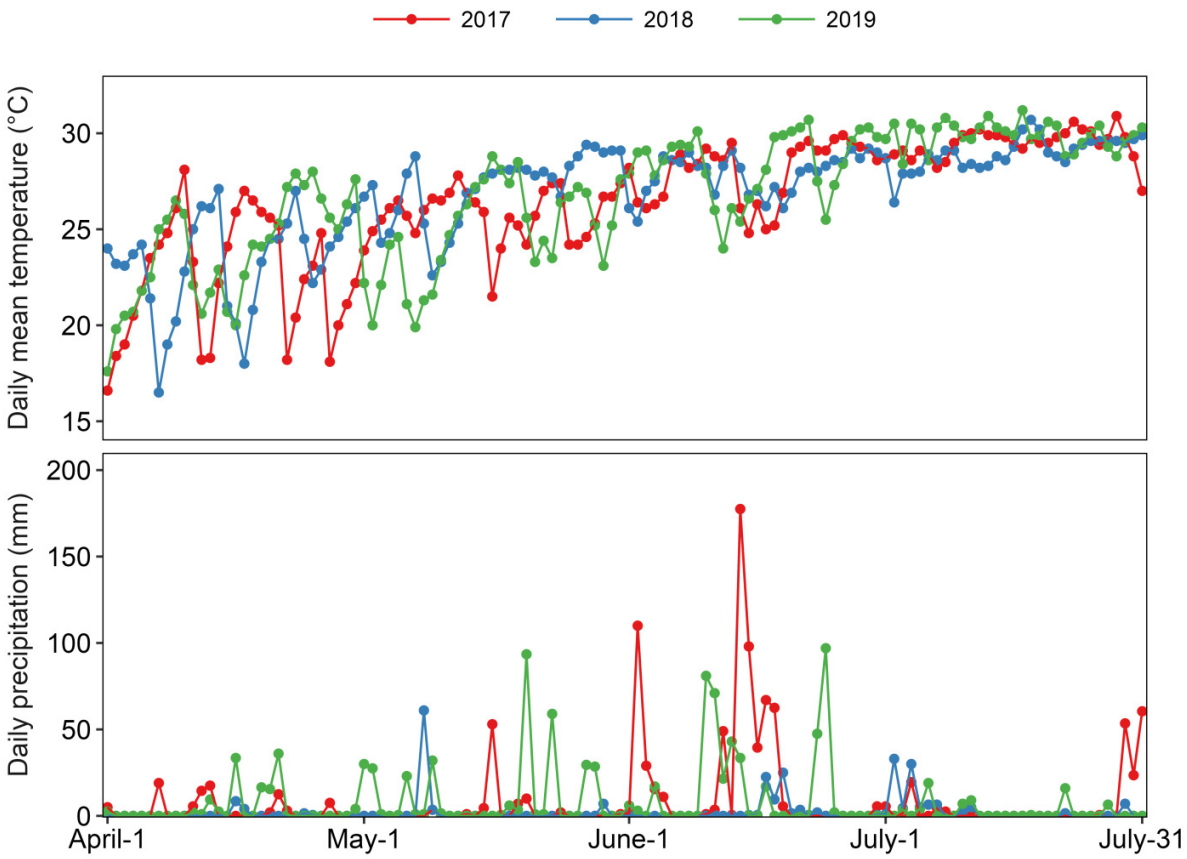


Figure S2. Daily mean temperature and precipitation of the study sites during the rice growth season (April to July) of the three study years. Observation data from the closest local weather station (Yuanli station) to the study farms were retrieved from the Central Weather Bureau Observation Data Inquire System (https://e-service.cwb.gov.tw/HistoryDataQuery/index.jsp).